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Ito et al.

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(54) **DROPLET DETECTING DEVICE AND INKJET PRINTER**

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B41J 29/393 (2006.01)

(52) **U.S. Cl.**
USPC **347/19**

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

Provided is an ink detecting module (**100**) that detects the discharge state of a liquid droplet by receiving a light beam emitted to a flying path of the liquid droplet discharged from a nozzle row (**103**) of an inkjet printer, the ink detecting module including: a light emitting unit (**104**) that emits a light beam; a light receiving unit (**105**) that receives the emitted light beam; and a module base (**108**) that integrally supports the light emitting unit (**104**) and the light receiving unit (**105**), the module base (**108**) including: positioning pins (**106**, **107**) that are engaged with the inkjet printer and determine the fastening position in the inkjet printer; and a fastening unit that is fastened to the inkjet printer, in which, in the state of being fastened to the inkjet printer, only the positioning pins (**106**, **107**) and the fastening unit are in contact with the inkjet printer.

5 Claims, 3 Drawing Sheets

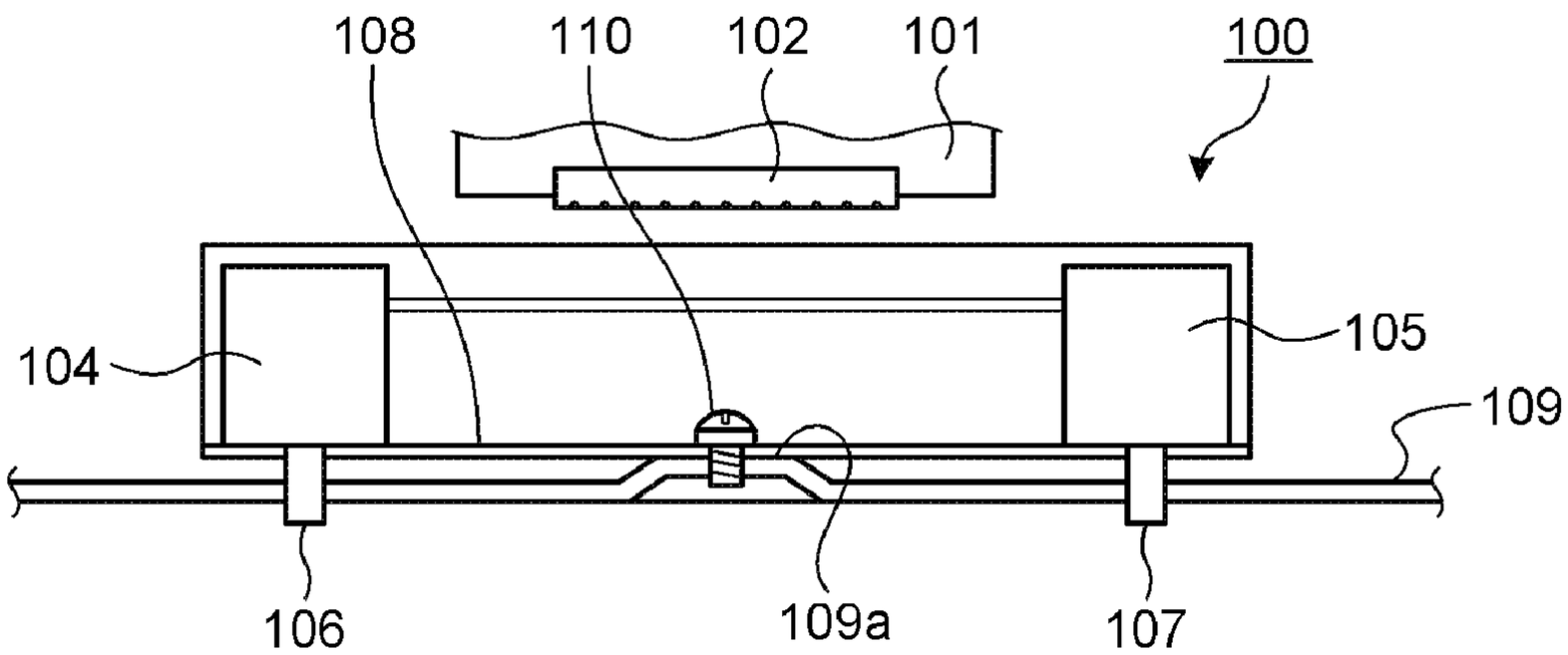

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FIG.1

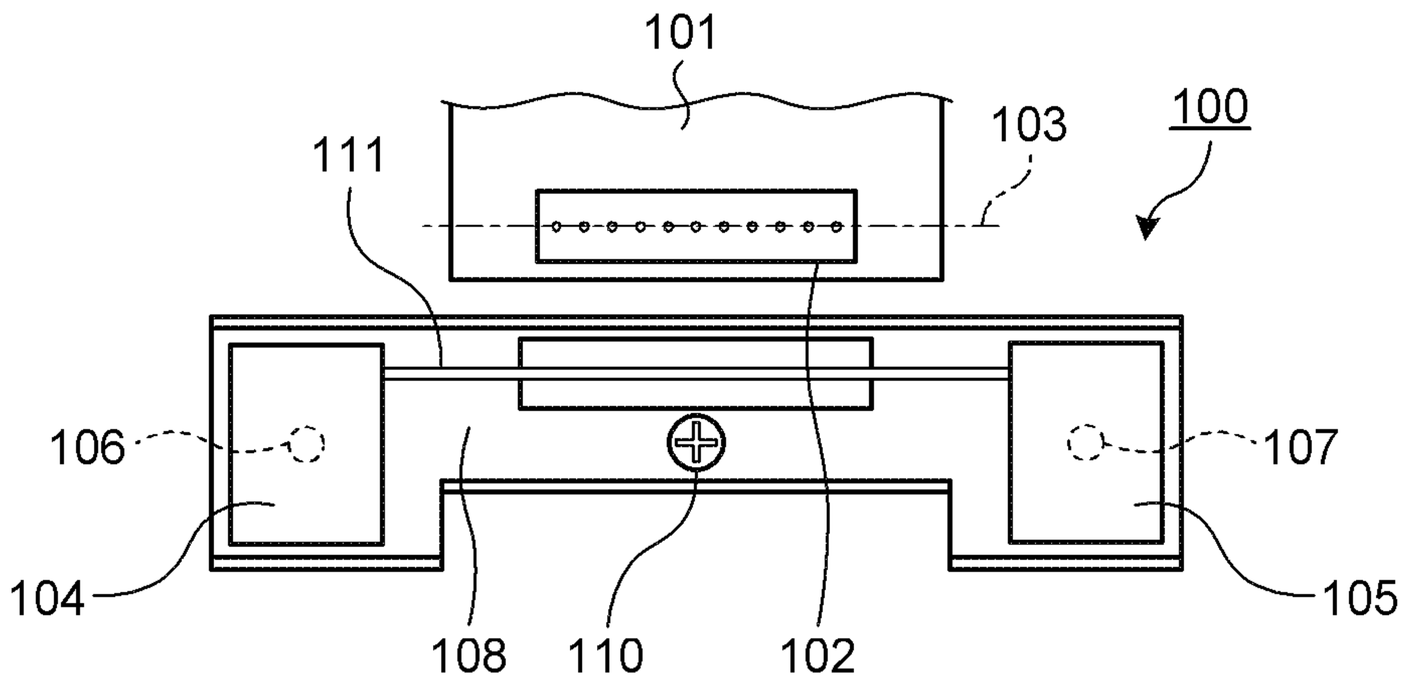

101
100
103
111
106
107
104
105
108
110
102

FIG.2

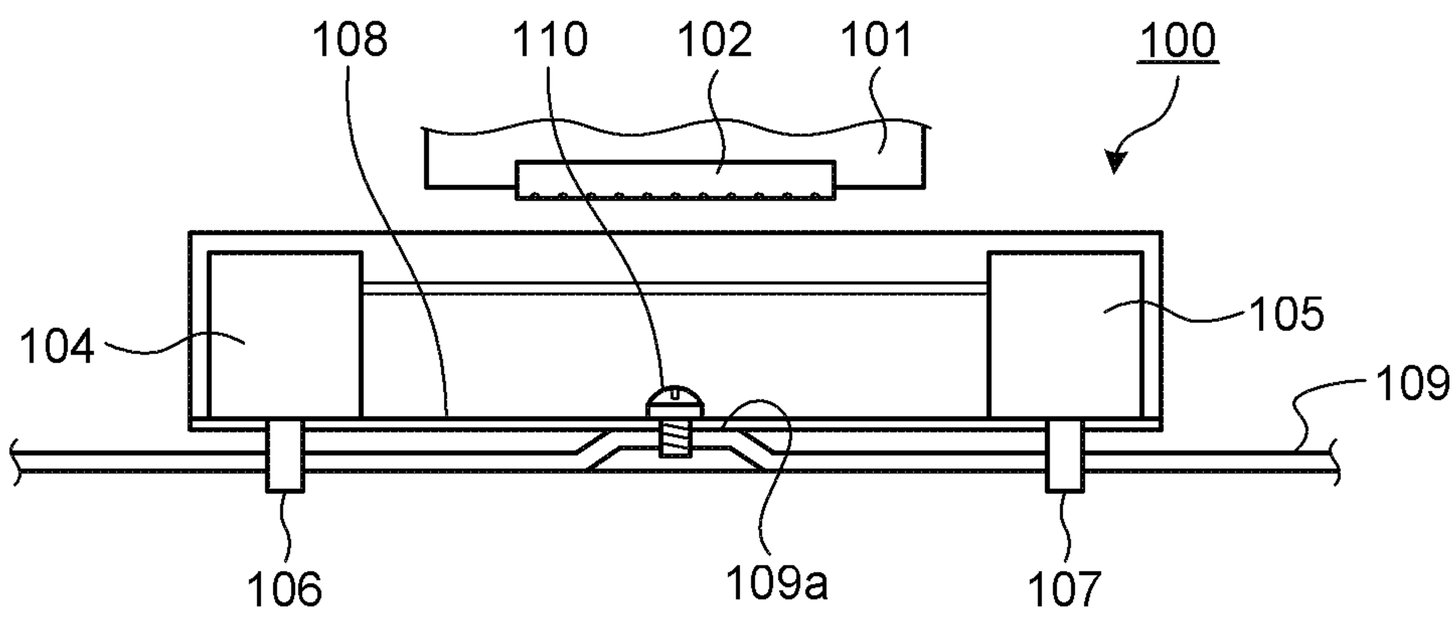

108
110
102
101
100
104
105
109
106
109a
107

FIG.3

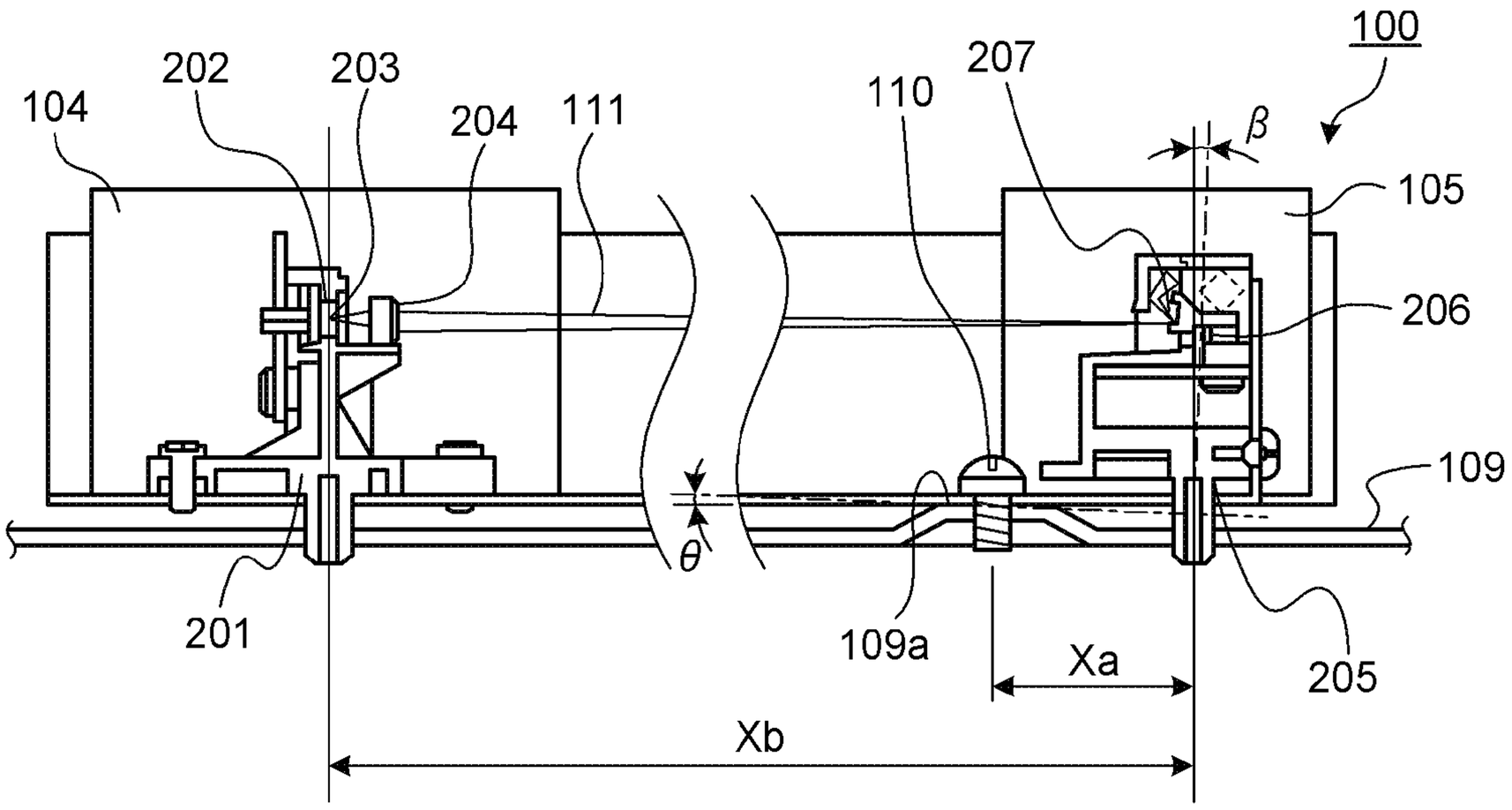

100
202
203
207
104
204
111
110
β
105
206
109
θ
201
109a
Xa
205
Xb

FIG.4

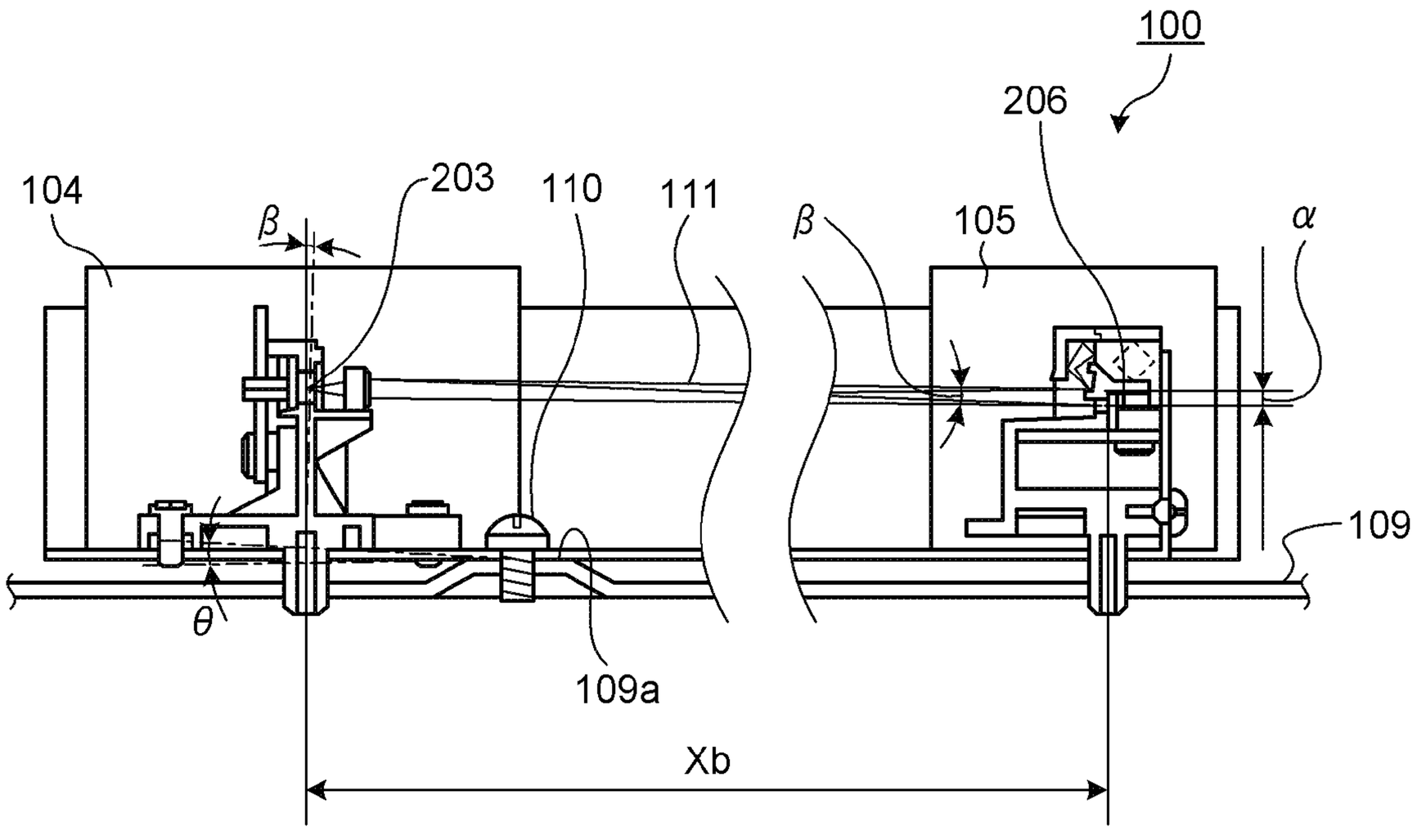

100
206
104
β
203
110
111
β
105
α
109
θ
109a
Xb

FIG.5

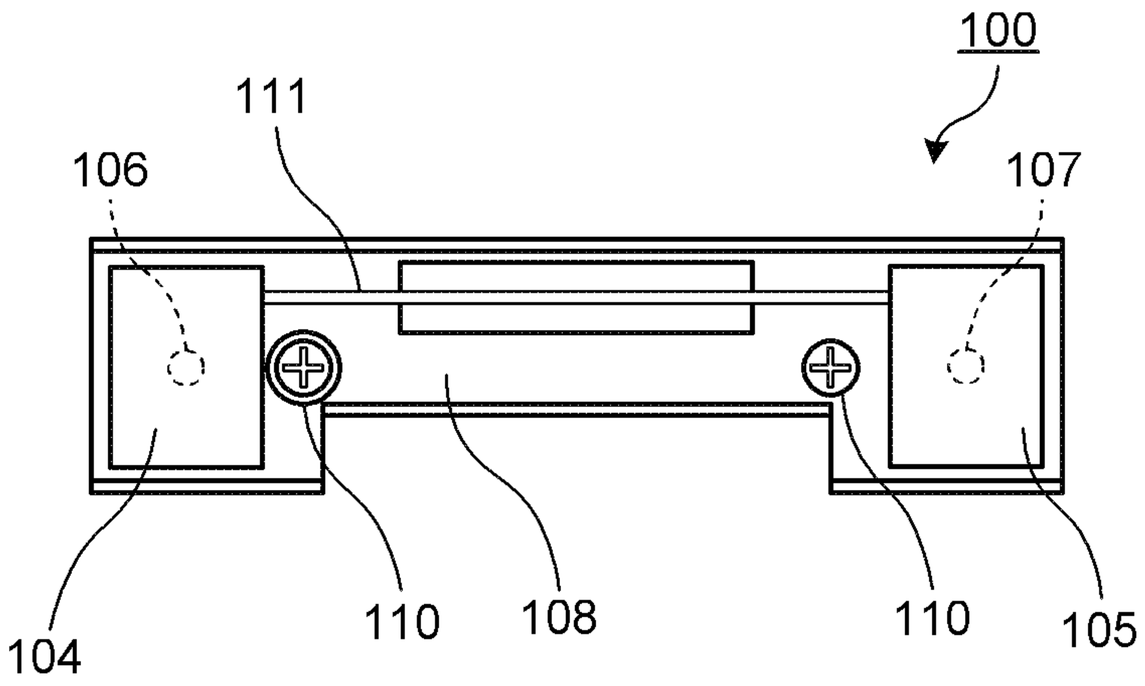
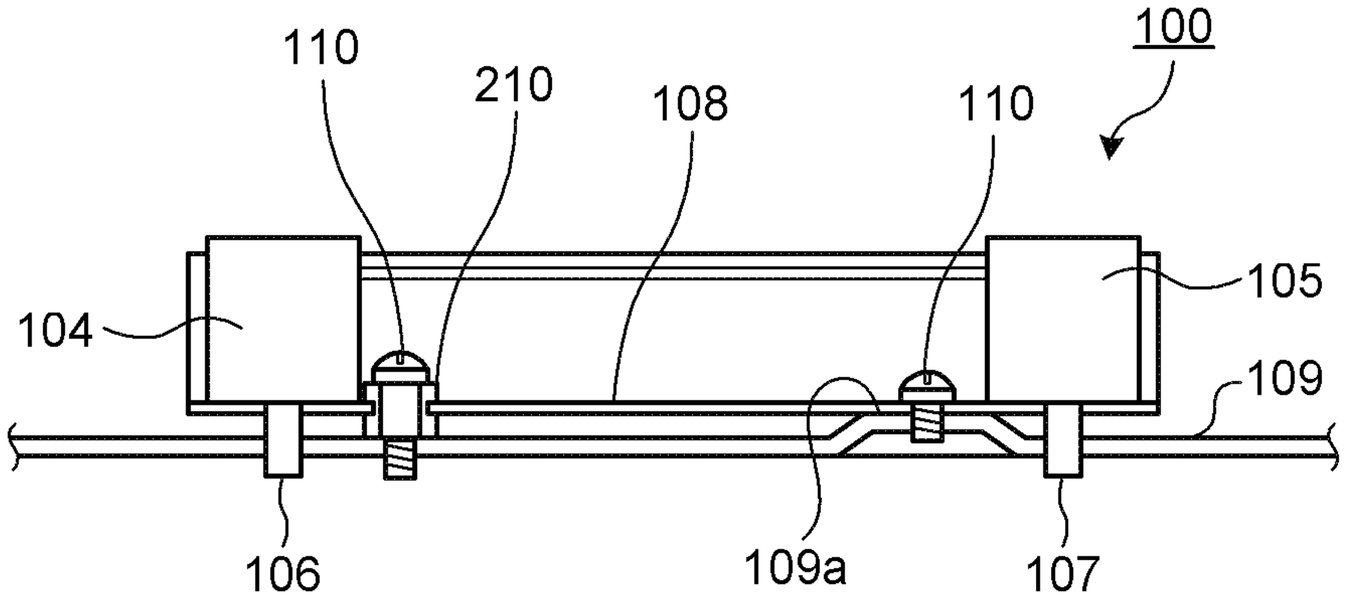

100
111
106
107
104
110
108
110
105

FIG.6


110
210
108
110
100
104
105
109
106
109a
107

DROPLET DETECTING DEVICE AND INKJET PRINTER

RELATED APPLICATIONS

This application is the U.S. National Phase under 35 U.S.C. §371 of International Application No. PCT/JP2010/050047, filed on Jan. 6, 2010, which in turn claims the benefit of Japanese Application No. 2009-007822, filed on Jan. 16, 2009, the disclosures of which applications are incorporated by reference herein.

TECHNICAL FIELD

The present invention relates to a droplet detecting device and an inkjet printer.

BACKGROUND

Conventionally, there is disclosed an inkjet-type recording apparatus that performs optical position adjustment between a light emitting module and a light receiving module with respect to a base member (for example, see Patent Literature 1). In this inkjet-type recording apparatus, the light emitting module and the light receiving module are fixed to a casing as the base member by adjusting the optical axes thereof.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Patent Publication No. 3509706

SUMMARY

Technical Problem

However, in regard to the conventional inkjet-type recording apparatuses described as above, disclosed is a technique of fixing the light emitting module and the light receiving module to the casing as the base member by adjusting the optical axes thereof. However, there is no consideration of maintenance of the accuracy, the stability, and the like in the optical axis adjustment when the modules are mounted in the main body (printer) after the adjustment. Accordingly, there is a problem in that the accuracy changes in the state in which a droplet detecting device configured to be integrated with a module base by adjusting the optical axes thereof is fixed to the main body (printer), and the function of the optical axis adjustment is not stable.

Solution to Problem

The present invention is contrived in view of the above, and the object thereof is to allow a droplet detecting device, configured to be integrated with a module base by adjusting the optical axes of a light emitting unit and a light receiving unit used as detection modules, to function stably without variations in accuracy in the state of being fixed to a main body (printer).

According to an aspect of the present invention, provided is a droplet detecting device that detects a discharge state of a liquid droplet by receiving a light beam emitted to a flying path of the liquid droplet discharged from a nozzle of an inkjet printer, the droplet detecting device including: a light emitting unit that emits the light beam; a light receiving unit that receives the emitted light beam; and a detection unit that includes a base unit integrally supporting the light emitting unit and the light receiving unit, wherein the base unit includes: at least two positioning units that are engaged with the inkjet printer and determine the fastening position onto the inkjet printer; and a first fastening unit that is fastened to the inkjet printer, and wherein, in the state of being fastened to the inkjet printer, only the positioning units and the first fastening unit are in contact with the inkjet printer.

According to another aspect of the present invention, the first fastening unit may be arranged at an approximate center of the detection unit, or at a position close to the light receiving unit from the center.

According to still another aspect of the present invention, the base unit may further include a second fastening unit that is fastened to the inkjet printer through an elastic member.

According to still another aspect of the present invention, the light receiving unit may receive scattering light that is generated when the light beam collides with the liquid droplet, and the detection unit may detect the discharge state of the liquid droplet based on light intensity of the scattering light.

According to still another aspect of the present invention, provided is an inkjet printer in which the droplet detecting device described above may be built.

Advantageous Effects of Invention

According to the present invention, obtainable is an advantage of allowing a droplet detecting device, configured so as to be integrated with a module base by adjusting the optical axes of a light emitting unit and a light receiving unit used as detection modules, to function stably without variations in accuracy in the state of being fixed to a main body (printer).

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a plan view illustrating the configuration of a droplet detecting device according to this embodiment.

FIG. **2** is a side view illustrating the configuration of the droplet detecting device of FIG. **1**.

FIG. **3** is an explanatory diagram illustrating the configuration of a light emitting unit and a light receiving unit and illustrating an example in which a fastening member is disposed at one position on the light receiving unit side.

FIG. **4** is an explanatory diagram illustrating the configuration of a light emitting unit and a light receiving unit and illustrating an example in which a fastening member is disposed at one position on the light emitting unit side.

FIG. **5** is a plan view illustrating a fastening method in which an elastic member is arranged in the configuration of FIG. **3**.

FIG. **6** is a side view illustrating a fastening method in which an elastic member is arranged in the configuration of FIG. **3**.

DESCRIPTION OF EMBODIMENTS

Hereinafter, preferred embodiments of a droplet detecting device and an inkjet printer according to the present invention will be described in detail with reference to the accompanying drawings.

Embodiment

FIG. **1** is a plan view illustrating the configuration of a droplet detecting device according to this embodiment, and FIG. **2** is a side view of FIG. **1**. FIGS. **1** and **2** illustrate an example of the configuration of an inkjet printer in which an

ink detecting module **100** is incorporated as a droplet detecting device. As shown in FIGS. **1** and **2**, the inkjet printer includes a carriage **101**, a recording head **102**, a nozzle row **103**, an ink detecting module **100**, a mounting base **109**, and a fastening member **110** including a screw and the like.

The ink detecting module **100** detects the discharge of liquid droplets by using a light emitting element and a light receiving element. The ink detecting module **100** includes a light emitting unit **104** having the light emitting element such as a laser diode, a light receiving unit **105** having the light receiving element such as a photodiode, and a module base **108** supporting the light emitting unit **104** and the light receiving unit **105**. In the module base **108**, positioning pins **106** and **107** are formed. The positioning pins **106** and **107** are pins that are used for determining the positions of the light emitting unit **104** side and the light receiving unit **105** side. A detection beam **111** is emitted from the light emitting unit **104** toward the light receiving unit **105**.

The mounting base **109** is a base, on which the ink detecting module **100** is mounted, located on the inkjet printer main body side. The mounting base **109** includes a mounting face **109***a* having a convex face that gives a predetermined gap between the mounting base **109** and the ink detecting module **100** for screw fastening.

As illustrated in FIGS. **1** and **2**, the light emitting unit **104** and the light receiving unit **105** are integrated with the module base **108** by being adjusted of the optical axes with respect to the positioning pins **106** and **107**. Then, the module base **108** is arranged at a portion corresponding to the positioning pins **106** and **107** of the mounting base **109** and then is screw-fastened with a fastening member **110** to the mounting face **109***a* at one position.

As above, by configuring the light emitting unit **104** and the light receiving unit **105** so as to be integrated with the module base **108**, the optical axis of the detection beam **111** is adjusted with respect to the positioning pins **106** and **107**. At this time, the light emitting unit **104** encases the light emitting element and a driving circuit thereof. The light receiving unit **105** encases the light receiving element and a detection circuit thereof.

In addition, the module base **108** needs to have rigidity, taking deformation due to assembly or the like and the misalignment of the optical axis due to distortion into consideration. Particularly, regarding the mounting of the light emitting unit **104**, there is likelihood that distortion occurs when the light emitting unit is mounted on the module base **108**, distortion occurs when the optical axis is adjusted, distortion occurs when it is mounted on the main body, and the like. In order to avoid these problem, there may be considered a configuration of increasing the plate thickness of the module base **108** or a configuration using die casting or resin molding so as to improve the rigidity of the module base **108**. However, when taking the rigidity into consideration, the shape is enlarged. Accordingly, when a tradeoff with the cost is considered, a chassis structure acquired by bending a metal plate or the like is preferable.

Next, a structure for minimizing the misalignment of the optical axis due to the mounting structure will be described. First, the mounting and the position determining structure of the ink detecting module **100** will be described. The detection beam **111** of a detection area that is located between the light emitting unit **104** and the light receiving unit **105** is positioned through adjustment of the optical axis, which is performed in advance, with respect to the positioning pins **106** and **107** of the module base **108**. In consideration of the misalignment of the optical axis attributable to the occurrence of distortion of the module base **108** that is caused by the bias of the weight balance of the ink detecting module **100**, the module base **108** is fastened to the mounting base **109** of the main body with the fastening member **110** that is disposed at an approximate center position of the ink detecting module **100**. As is obvious, it is preferable that the adjustment of the optical axis of the ink detecting module **100** is adjusted through a similar fixing structure.

In addition, it is preferable to consider the area and the flatness of the mounting face **109***a* of the mounting base **109** of the main body for suppressing the occurrence of distortion at the time of the fastening to be minimal. In addition, units other than the fastening unit need to have a sufficient gap so as not to interfere with the ink detecting module **100**. In a case where other fastening units are arranged so as to protect the ink detecting module **100** from an unpredicted external force applied to the ink detecting module **100**, it is necessary to form a gap so as to prevent the interference by using a shoulder screw or the like.

Through the fastening as above, the detection beam **111** and the nozzle row **103** are parallel to each other. In addition, the status of ink discharging can be checked by moving the carriage **101** so as to allow the nozzle row **103** and the detection beam **111** to match with each other and to allow ink from the nozzle row **103** to sequentially collide with the detection beam **111**.

Next, the detection capability and the like based on the arrangement of the fastening member **110** in the above-described configuration will be described with reference to FIGS. **3** and **4**. FIG. **3** is an explanatory diagram illustrating the configuration of the light emitting unit **104** and the light receiving unit **105** and illustrating an example in which the fastening member **110** is disposed at one position on the light receiving unit **105** side. As illustrated in FIG. **3**, the light emitting unit **104** includes an LD block **201**, a laser **202**, a light emitting point **203**, and a collimate lens **204**. The light receiving unit **105** includes a PD block **205**, a light receiving surface **206**, and a reflection surface **207**.

As illustrated in FIG. **3**, the detection beam **111**, which is diffused light whose light emitting point is the light emitting point **203** of the laser **202**, is formed as an approximately parallel beam through the collimate lens **204**. In this embodiment, in the state in which the detection beam **111** is detected, the adjustment of the optical axis and the focus detection are performed in such a manner that the beam waist of the detection beam **111** is positioned on the reflection surface **207** of the PD block **205**. Then, treatment of stray light is performed by guiding the beam reflected from the reflection surface **207** into the inside of the PD block **205**. Meanwhile, the light receiving surface **206** is light-shielded by the end surface of the reflection surface **207**, and through this configuration, the scattering light, generated when an ink droplet collides with the beam, can be detected.

In such a configuration, for example, the output of scattering light from all the nozzle rows can be stably detected when the diameter of the beam on the reflection surface **207** is about 0.1 mm, and a distance between the center and the end surface is 0.4 mm. Accordingly, this state needs to be maintained also in the state of being built in the main body. However, the task of this is how to suppress the distortion occurring at the time of mounting, in a case where the above-described module base **108** has the metal-plate chassis structure described above, and the fastening position thereof becomes important.

In FIG. **3**, the fastening member **110** is disposed at one position on the light receiving unit **105** side. At this time, in a case where there is an abnormality such that a distortion θ occurs when mounting the module base to the mounting face **109***a*, the light receiving surface **206** is influenced as inclina-

tion β. However, a distance Xa up to the fastening unit is short, and thus the amount of the position misalignment is such an extent as not to influence the detection capability. In addition, since the light emitting unit is separated therefrom by a distance Xb, the effect of the distortion on the light emitting unit **104** is not much.

FIG. **4** is an explanatory diagram illustrating the configuration of the light emitting unit **104** and the light receiving unit **105** and illustrating an example in which the fastening member **110** is disposed at one position on the light emitting unit **104** side. In FIG. **4**, in a case where there is an abnormality such that a distortion θ occurs when mounting the module base onto the mounting face **109***a*, the inclination of the light emitting point **203** is β, and the detection beam **111** also inclines by the inclination β. In addition, at the leading end of the detection beam **111**, since the distance Xb is long, the amount α of beam inclination is created. In this example, the detection beam **111** enters up to the light receiving surface **206** due to the amount α of inclination of the beam, rendering the scattering light undetectable.

An approximate calculation of the amount α of inclination of the beam is as below. The distortion of the fastening unit of 0.05 mm is increased up to 1 mm at the light receiving position based on "beam inclination amount α=distortion θ×distance Xb/fastening unit diameter (−=0.05×200/10=1)" when the distortion θ of 0.05 mm occurs with the diameter of the fastening unit=ϕ10 mm, and a distance from the light emitting point **203** to the light receiving surface **206** Xb=200 mm.

Accordingly, it can be said that a fastening arrangement is more effective in an arrangement where the fastening position gets closer to the light receiving unit **105** side shown FIG. **3** than in an arrangement where a fastening position is near the center as shown FIG. **1**. Because the configuration does not likely to give the influence of the distortion to both side of the light emitting unit **104** and the light receiving unit **105** disposed on both sides.

However, in the configuration of FIG. **3**, a case is considered in which the detection range is long and there is a problem in the stability of the maintenance of the fastening due to the weight balance of the ink detecting module **100** or the like. A configuration example addressing such as case is illustrated in FIGS. **5** and **6**. In the configuration as illustrated in FIGS. **5** and **6**, by fastening the fastening member **110** through an elastic member **210** to the light emitting unit **104** side, the stability of the maintenance can be achieved while suppressing the distortion due to the fastening to be minimal. In addition, all the fastening units may be fastened through buffer members.

As described above, the light emitting unit **104** and the light receiving unit **105** are integrated with the module base **108** and the optical axes thereof are adjusted with respect to the positioning pins **106** and **107**. Then, the module base **108** is disposed in portions of the mounting base **109** that correspond to the positioning pins **106** and **107** and thereafter is configured so as to be screw-fastened at one position on the mounting face **109***a* by the fastening member **110**. Accordingly, the distortion of the module base **108** at the time of fastening can be reduced to be minimal. In addition, since it is possible to suppress the occurrence of the deviation of the optical axes in the state where the optical axes are adjusted while the module base being mounted on the main body, it is possible to improve the assembly capability and the stability of the detection capability and to provide a low-cost base structure.

In addition, by setting the above-described fastening position to a position near the center of the ink detecting module **100** or to a position near to the light receiving unit **105**, the influence of the distortion caused by the fastening of the light emitting unit **104** on the light emitting point **203** can be reduced; and the occurrence of the deviation of optical axes in the state where the optical axes have been adjusted in the detection state while the module base being mounted on the main body can be reduced, whereby it is possible to improve the assembly capability and the stability of the detection capability and to provide a low-cost base fastening configuration.

In addition, by fastening through the elastic member **210** located at least at one position in a gap portion between the ink detecting module **100** and the mounting base **109** other than the fastening unit, the stability of the detection can be maintained even when the detection length is long, and accordingly, a long printing head can become also applicable.

In addition, in a configuration where the optical axes of the light emitting device and the light receiving device are offset and where the scattering light is detected thereby, the deviation of the optical axes gives high influence over the detection capability. In the case of such a detection configuration, especially, by employing a technique of this embodiment that is capable of reducing the distortion of the module base **108** at the time of fastening to be minimal, it is possible to improve the assembly capability and the stability of the detection capability, and to provide a low-cost base structure. In addition, by mounting the droplet detecting device (for example, the configuration of FIG. **1** or **5**) represented by this embodiment into an inkjet printer, it is possible to provide a low-cost inkjet printer having stable printing capability.

INDUSTRIAL APPLICABILITY

As described above, a droplet detecting device and an inkjet printer according to the present invention are useful for a droplet detecting device and an inkjet printer that detect the discharge of liquid droplets from a nozzle and, particularly, are suitable for a device or a system in which a light emitting device and a light receiving device are integrally mounted on a main body through adjustment of the optical axes thereof.

REFERENCE SIGNS LIST

100 INK DETECTING MODULE
101 CARRIAGE
102 RECORDING HEAD
103 NOZZLE ROW
104 LIGHT EMITTING UNIT
105 LIGHT RECEIVING UNIT
106, **107** POSITIONING PINS
108 MODULE BASE
109 MOUNTING BASE
109*a* MOUNTING FACE
110 FASTENING MEMBER
111 DETECTION BEAM
210 ELASTIC MEMBER

The invention claimed is:

1. A droplet detecting device that detects a discharge state of a liquid droplet by receiving a light beam emitted to a flying path of the liquid droplet discharged from a nozzle of an inkjet printer, the droplet detecting device comprising a detection unit, the detection unit including:

a light emitting unit that emits the light beam;

a light receiving unit that receives the emitted light beam; and

a base unit integrally supporting the light emitting unit and the light receiving unit,

wherein the base unit includes:

at least two positioning units that are engaged with a mounting base of the inkjet printer and determine a fastening position of the detection unit onto the inkjet printer; and

a first fastening unit that fastens the base unit to the mounting base of the inkjet printer, and

wherein, in the state of the detection unit being fastened to the inkjet printer, only the positioning units and the first fastening unit are in contact with the mounting base of the inkjet printer.

2. The droplet detecting device of claim **1**,

wherein the first fastening unit is arranged at an approximate center of the detection unit, or at a position close to the light receiving unit from the center.

3. The droplet detecting device of claim **1**, wherein the light receiving unit receives scattering light that is generated when the light beam collides with the liquid droplet, and

the detection unit detects the discharge state of the liquid droplet based on light intensity of the scattering light.

4. An inkjet printer in which the droplet detecting device according to claim **1** is built.

5. A droplet detecting device that detects a discharge state of a liquid droplet by receiving a light beam emitted to a flying path of the liquid droplet discharged from a nozzle of an inkjet printer, the droplet detecting device comprising a detection unit, the detection unit including:

a light emitting unit that emits the light beam;

a light receiving unit that receives the emitted light beam; and

a base unit integrally supporting the light emitting unit and the light receiving unit,

wherein the base unit includes:

at least two positioning units that are engaged with a mounting base of the inkjet printer and determine a fastening position of the detection unit onto the inkjet printer;

a first fastening unit that fastens the base unit to the mounting base of the inkjet printer; and

a second fastening unit that fastens the base unit to the mounting base of the inkjet printer through an elastic member,

wherein, in the state of the detection unit being fastened to the inkjet printer, only the positioning units and the first and second fastening units are in contact with the mounting base of the inkjet printer.

* * * * *